METHOD FACTSHEET

# SIMPLE MATRIX APPROACH

## Introduction

**Matrix Approaches** are a quick and simple way to get an overall spatially-explicit picture of the ES in case study areas. The method is based on the idea of linking tabular spreadsheet data and spatial data together, i.e. joining external datasets to spatial units to create maps. The spreadsheet format data can be collected, for example, as expert evaluation or constructed from indicators or statistics. Simple application of the approach typically involves land use or land cover (LULC) datasets, although other datasets can be used.

This document is designed to introduce you to the ***basics of the matrix approach***. There is a separate factsheet is available on an *"Advanced Matrix Approach"* that you may wish to read as a follow on to this factsheet**.** The advanced version of the matrix method has been suggested to improve representation of the transdisciplinary issues that are often related with ES studies (e.g. including advanced sources of knowledge, encouraging collaboration amongst stakeholders). It utilises an extensive set of spatial datasets grouped into themes (instead of using solely LULC data) combined with both scientific experts' and local actors' scorings. The method was developed to assess spatial variation in ES provision potential of green infrastructure in spatial planning.

## Keywords

GIS; Ecosystem services; Spreadsheets; Matrix; Expert scoring; Stakeholder engagement; Semi-quantitative methods.

## Why would I chose this approach?

Simple matrix approaches are great as a means to:

**1) To get a quick overview of the potential supply of, demand for and budgets of ecosystem services.**
Burkhard et al. (2012) used spreadsheets for creating a scored ES reclassification table (also often called an expert knowledge table) which was coupled with the CORINE Land cover (CLC) database to produce ES supply, demand and budgets maps. By linking expert evaluation of the ability of each LULC class to supply ES as well as the demand for various ES within the same LULC classes, overview maps of both supply and demand were quickly derived. When supply and demand were calculated together, budgets were created.

**2) To detect possible areas of conflict where multiple land use interests or needs for biodiversity conservation exist.**
A spatially-explicit ES mapping exercise can be used for detecting possible areas of conflict where multiple land use interests or needs for biodiversity conservation exist (e.g. Vihervaara et al. 2010; 2012).

In addition, optimising multiple ES and conservation needs is possible. Potentially relevant biodiversity datasets include for example EUNIS (e.g. Natura 2000 habitats), agricultural parcels (e.g. grasslands, pastures) and multi-source forest inventories. In general, ES assessments can be extended by using additional datasets related to land cover types, such as statistics (e.g. Kandziora et al. 2013), modelled data (e.g. Nedkov & Burkhard 2012) or monitoring data (Baral et al. 2013).

## What are the main advantages of the approach?

- Relatively easy and fast to perform;
- Draws on existing data, can handle missing data, and expert knowledge can be included;
- Basic knowledge of spreadsheets and GIS is usually enough;
- Open source software can be used;
- Simultaneous assessment of multiple ES;
- Applicable at different scales: best possible datasets of appropriate resolution need to be used accordingly;
- Naturally an integrative / holistic approach;
- Suitable for transdisciplinary research problems;
- Easily adoptable, transparent and flexible.

NB Consider ***Advanced Matrix Approaches*** (separate fact sheet) for the following additional advantages:

- Useful in a participatory approach with stakeholders;
- Takes also into account features that reduce the provision potential;

## What are the constraints/limitations of the approach?

- Availability of the background data might be a restraint;
- If a matrix using LULC data is applied, the data might be too coarse to study small case study areas;
- Data preparation can be quite a long and demanding task when a wide array of spatial datasets is used (GreenFrame);
- Possibly biased answers by the experts;
- Reliability of the results should always be evaluated;
- Wide matrices can be quite exhausting to fill in with scores and loss of concentration can result in errors in scores.

## What types of value can the approach help me understand?

The approach can be used for both the supply and demand of ecosystem services. It can provide outputs across all ecosystem service types and represent both biophysical and socio-cultural values. It is not designed to provide information on monetary values.

## How does the approach address uncertainty?

Spreadsheet-type methods do not generally address uncertainty explicitly.

## How do I apply the approach?

The following steps need to be undertaken to apply the spreadsheet-type method within a case study:

**Step 1:** Gather relevant spatial datasets on land use, land cover type, habitats, biodiversity, etc. in GIS format. The most commonly used GIS data on LULC for Europe is CORINE which is readily available. However, other relevant spatial datasets can also be used, but it is important to evaluate their accuracy. It is also important to ensure that spatial datasets of an appropriate resolution are used for the spatial scale of the case study. The LULC or other classes in these datasets form the basis for the spatial interpolation of the spreadsheet data.

**Step 2:** Create a fit for purpose spreadsheet arrangement following the LULC classes and the selected ES (see Figure 1 below) where the first column contains the names of the CORINE land cover classes). The ES to be assessed are usually listed in the columns and the LULC classes in rows. A column with identical numbers for LULC classes helps to link the matrix information to the GIS data.

| CORINE land cover type: | Ecological Integrity Σ | Abiotic heterogeneity | Biodiversity | Biotic waterflows | Metabolic efficiency | Exergy Capture (Radiation) | Reduction of Nutrient loss | Storage capacity (SOM) | Regulating services Σ | Local climate regulation | Global climate regulation | Flood protection | Groundwater recharge | Air Quality Regulation | Erosion Regulation | Nutrient regulation | Water purification | Pollination | Provisioning services Σ | Crops | Livestock | Fodder | Capture Fisheries | Acquaculture | Wild Foods | Timber | Wood Fuel | Energy | Biochemicals and Medicine | Freshwater | Cultural services Σ | Recreation& Aesthetic Values | Intrinsic Value of Biodiversity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Continuous urban fabric | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Discontinuous urban fabric | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Industrial or commercial units | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Road and rail networks | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Port areas | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Airports | 7 | 1 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mineral extraction sites | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| Dump sites | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Construction sites | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green urban areas | 18 | 3 | 3 | 2 | 1 | 4 | 3 | 2 | 11 | 2 | 1 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 3 | 0 |
| Sport and leasure facilities | 16 | 2 | 2 | 2 | 1 | 4 | 3 | 2 | 9 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 |
| Non-irrigated arable land | 22 | 3 | 2 | 3 | 4 | 5 | 1 | 4 | 5 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 21 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 0 |
| Permanently irrigated land | 21 | 3 | 2 | 5 | 2 | 5 | 1 | 3 | 5 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 5 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| Ricefields | 20 | 3 | 2 | 5 | 1 | 5 | 1 | 3 | 4 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Vineyards | 14 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 5 | 5 | 0 |
| Fruit trees and berries | 21 | 4 | 3 | 4 | 2 | 3 | 2 | 3 | 19 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 5 | 13 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 0 | 0 | 5 | 5 | 0 |
| Olive groves | 17 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 7 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 12 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 0 | 0 | 5 | 5 | 0 |
| Pastures | 24 | 2 | 2 | 4 | 5 | 5 | 2 | 4 | 8 | 1 | 1 | 1 | 1 | 0 | 4 | 0 | 0 | 0 | 10 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 3 | 0 |

scale for assessing capacities:
- 0 = no relevant capacity
- 1 = low relevant capacity
- 2 = relevant capacity
- 3 = medium relevant capacity
- 4 = high relevant capacity
- 5 = very high relevant capacity

Figure 1. An example spreadsheet matrix of ecosystem services and land cover classes

**Step 3:** Test your matrix with expert colleagues to find out any possible errors that might occur.

**Step 4:** Collect expert evaluation scores within spreadsheet tables based on questionnaire surveys, interviews or workshops. Whatever method is used to collect the evaluation score, it is crucial that the respondents are carefully selected to represent the case study area and issue. Unambiguous definitions for each ES and other unclear terminology should be provided to all the experts to ensure they have the same understanding of how to fill the table. Scores are derived from an expert evaluation based on the expected ability of all LULC classes to supply ES and in a separate sheet the demand for such services within current LULC classes. Simple calculation rules are applied between the columns.

**Step 5:** Collect all the scores from different respondents in one file and derive the median or mean value per LULC class and ES. Save the scores to a database file (*.dbf) or Excel format (.xls).

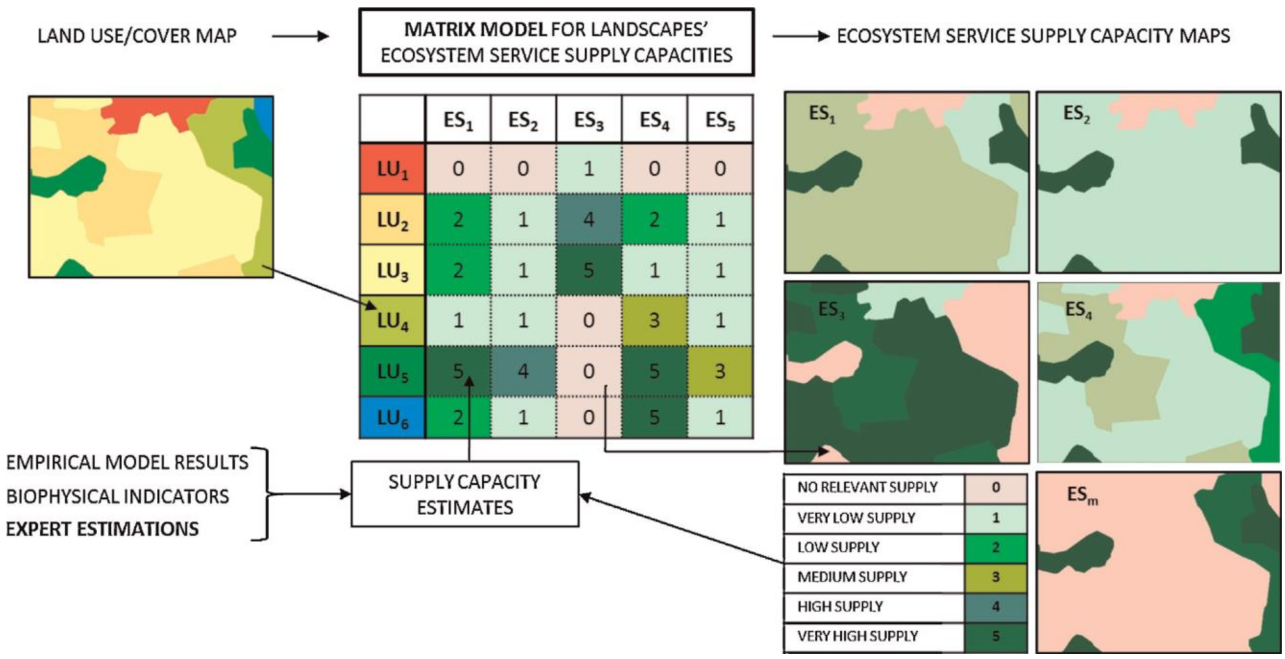


Figure 2. Spatial representation of ES provision using the Matrix model

**Step 6:** Import the data from the spreadsheet to a GIS programme to illustrate the results in a map (see figure 2). Joining the imported table to the spatial datasets enables a spatial representation of ES provision to be generated. It is possible to open Excel tables directly in common GIS software, such as ArcGIS, and work with them in the same way as other tabular data sources. For example, you can add them to ArcMap, preview them in ArcCatalog, and use them as inputs to Geoprocessing tools. Simple assessments can be undertaken with basic overlaying techniques (e.g. Geoprocessing Tools, Raster Calculator and Overlay Tools in ArcGIS). Maps can be finalized in Layout View.

**Step 7:** Evaluate the relevance and uncertainties of the results. It is also useful to elaborate them with the experts in a second workshop. Comparisons can also be made with similar case studies.

## Requirements

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| *Data* | ☑ Data is available<br>☑ Need to collect some new data<br>☑ Need to collect lots of new data | The need to collect new data depends on: (i) the objectives of the case study; (ii) the matrix-type method selected (based solely on LULC or based on a wide variety of spatial datasets as in GreenFrame method); and (iii) on the availability of data from the case study area. |
| *Type of data* | ☑ Qualitative<br>☑ Quantitative | Spatially-explicit datasets (vector or raster) and additional information are needed. |
| *Expertise and production of knowledge* | ☑ Work with researchers within your own field<br>☑ Work with researchers from other fields<br>☑ Work with non-academic stakeholders | Basic knowledge in spreadsheets and GIS are needed to conduct the assessment successfully. Facilitating expert evaluations and focus groups needs social and stakeholder engagement skills as well as the ability to clarify the ES concept, ES categories, the content and quality of various spatial datasets, and the scoring task in an understandable and uniform way. |

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|---|---|---|
| *Software* | ☑ Freely available<br>☐ Software licence required<br>☐ Advanced software knowledge required | Any general spreadsheet software (e.g. Excel, Lotus123, Google Spreadsheets) is suitable to collect data in tabular form. Before the data is imported into a GIS programme, the data must be saved to a database IV file (*.dbf) or Excel format (*.xls). The method can be applied using any type of GIS software, licensed (ArcGIS) or open source (GRASS, QGIS, R, etc.). The LULC data should be in Shapefile format (*.shp) or a raster image (e.g. *.tiff, *.img), with LULC coding. The GIS software is needed to join the tabular data to the spatial data for the spatial analysis and creating output maps. |
| *Time resources* | ☑ Short-term (< 1 year)<br>☑ Medium-term (1-2 years)<br>☐ Long-term (more than 2 years) | Time and economic resources depend on the availability and accessibility of spatial datasets, on the need for pre-preparing the datasets for analysis, and on the expertise of the researchers and GIS specialists. |
| *Economic resources* | ☑ < 6 person-months<br>☑ 6-12 person-months<br>☐ > 12 person-months | Similar to time resources. |
| *Other requirements* | When using GreenFrame, expertise is needed in carrying out focus groups and working together with researchers from other fields as well as with local and regional actors. Basic knowledge of statistics is also needed (understanding variation, mean, median, etc.). | |

## Where do I go for more information?

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